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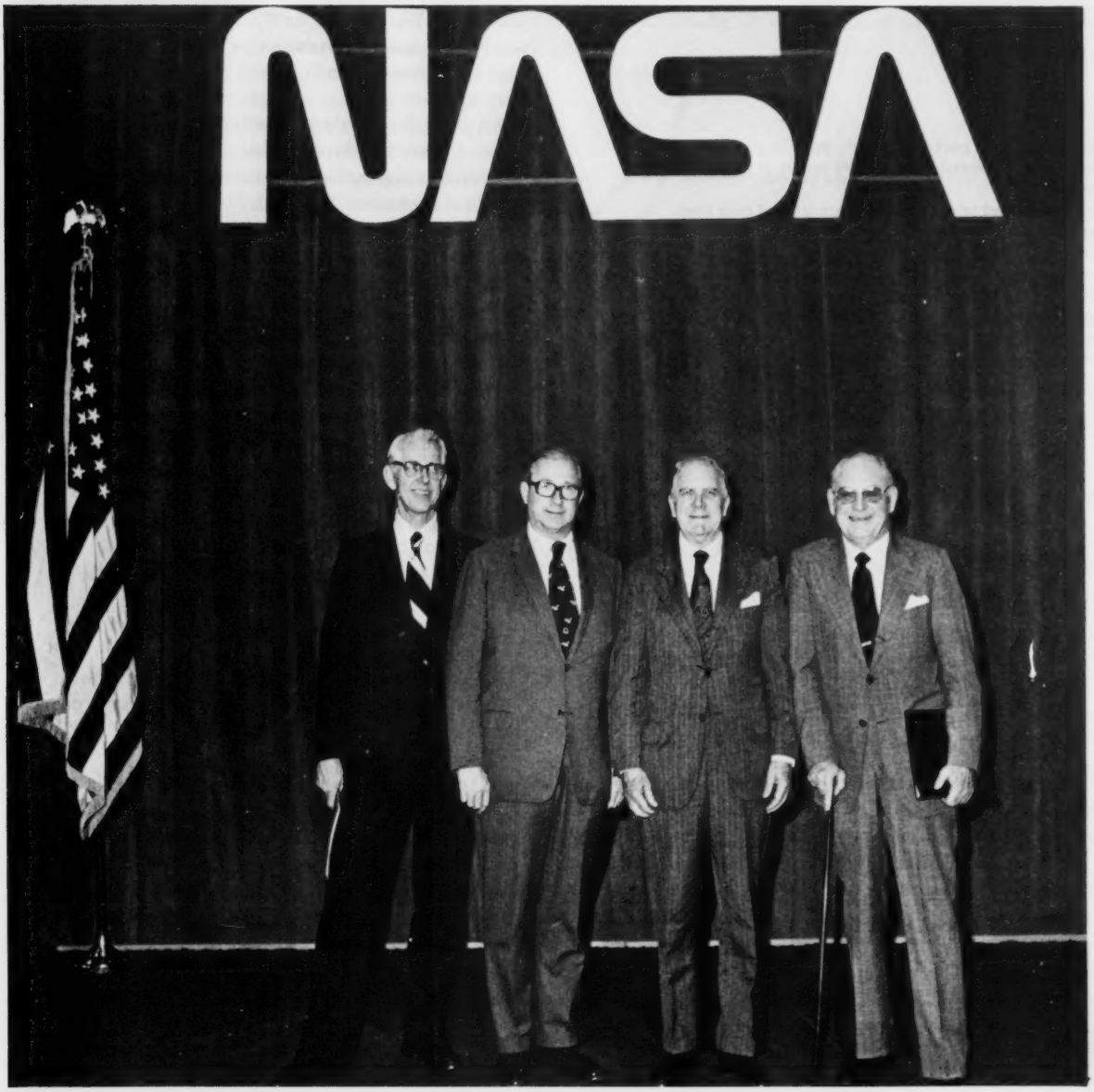

Cover

NASA History Makers—All four of NASA's Administrators gathered to pay homage to the memory of Dr. Hugh L. Dryden, first Deputy Administrator of the agency. The occasion was the March 1976 dedication of NASA's Hugh L. Dryden Flight Research Center at Edwards, Calif., formerly the Flight Research Center. Left to right are: Dr. James C. Fletcher, Administrator since April 1971; Dr. Thomas O. Paine, Administrator October 1968 to September 1970; James E. Webb, Administrator February 1961 to October 1968; and Dr. T. Keith Glennan, Administrator October 1958 to January 1961.

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Letter from Washington

Dear Colleagues:

One hundred years ago, Alexander Graham Bell's new invention, the telephone, was the highlight of the Philadelphia Exhibition. One observer noted, "Of all the gifts which young America received on its 100th birthday, the telephone proved to be the most valuable."

Fletcher

One hundred years later, only six years after Telstar, the world's first privately financed satellite, was put into orbit, the Bicentennial year is being called the "Year of the Communications Satellite." Of NASA's 19 space launches scheduled for 1976, 13 are communications satellites, nine of which are privately financed for commercial use.

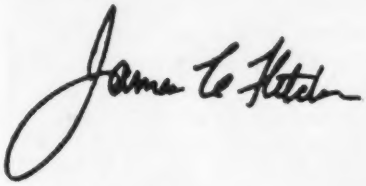
Telstar, Early Bird, and the other Intelsats, ATS-6, Marisat, the Communications Technology Satellite, Comstar, Westar and Satcom—these satellites have revolutionized world communications in a very short time.

- A global satellite system, Intelsat, has been fully established, and is being expanded continuously to meet the rapid growth in demand for satellite services.
- One hundred and seven countries, territories or possessions on six continents are leasing satellite services full time.
- More than a billion people, one of every four persons on Earth, can see an international event on television—"live via satellite"—as it happens.
- A major portion of all long-distance international communications and more than two-thirds of all transoceanic communications are by satellite.

Communications satellites have more than repaid the cost of their development and launching. The cost of a telephone call from New York to London is 55 percent lower today than it was before the Early Bird satellite, Intelsat I, entered service in 1965. The cost of a one-hour television transmission between New York and Paris is 80 percent lower than the charge established for the same transmission by Early Bird. Before satellites, a West-Coast-to-Japan cable circuit cost $15,000 a month; today a communications satellite makes the same service available for $4,000 per month.

Satellites that directly broadcast television to community receivers are demonstrating their potential for delivering educational, medical and other services to remote and hitherto unreachable populations. This tool can be of immense benefit to developing countries seeking to raise literacy and improve the health of their peoples. Such exploitation of space may well be seen by future observers as the most valuable gift given to the world by America during the celebration of its 200th birthday.

Sincerely,



James C. Fletcher

Monthly NASA Highlights

What Will We Find on Mars?

"The mission of the space program, the end product of essentially all our systems, is information, knowledge and most especially precise knowledge," said Dr. James C. Fletcher about the landing of the Viking spacecraft on the planet Mars on July 4. "From space exploration we derive not only technical data about other planets, but a better understanding of our own Earth and where it may be heading."

As this is being written, two Viking spacecraft are approaching Mars to carry out the most complex and comprehensive series of investigations ever attempted in an automated space mission. If all goes according to plan, the first Viking will have arrived at Mars and the first returned data will be under study as you are reading this. What is Mars really like? What do we expect to learn from this mission?

The correct answer to the first question must be postponed until we have acquired a large amount of knowledge directly from the planet itself. Mariner 9 provided more information about Mars than all the previous space missions and ground observations combined. From these data we believe that at least some of Mars' early history parallels that of Earth. There is evidence of extensive impact cratering, hydraulic activity, wind erosion, volcanism, and crustal movement. Thus, Mars is not only of great scientific interest in its own right, but also it is an excellent model for comparative study. Because of the similarities and differences between the two planets, we may learn much from Mars that will enable us to understand better the natural processes that determine our own environment.

What will we learn from Viking? We can only speak of the areas in which observations will be made. Specifics are the subject of speculation and we have learned from experience that speculations based upon inadequate or uncertain information are not fruitful. Within the past 100 years we have seen the "canali" of Schiaparelli and the canals of Lowell come and go along with Sinton's bands, the moonlike image portrayed by the first Mariners and various other Mars "models." Our current scientific and engineering models are based on the most reliable scientific data available, but we recognize that these data are far from adequate. Viking will strengthen them, and perhaps significantly modify them.

The Viking Orbiters are equipped to study the form, figure, gravity and ephemeris of the planet (a table of computed positions at regular intervals), along with time and space variations in its ionosphere, atmosphere (including water vapor), surface features and thermal balance. During atmospheric entry and descent, the Lander will determine the composition and structure of the ionosphere and upper atmosphere as well as the temperature and pressure profile of the lower atmosphere. Atmospheric measurements will continue after landing to determine surface composition and pressure and how these parameters may vary on a daily basis or over longer periods.

Immediately upon landing, the seismometer and meteorology instruments will be turned on; camera #2 will take the first images of the surface, and the preparations for analysis of the first sample of Mars surface material will begin. These activities will continue for the next seven SOLs (Martian days) during which camera #1 will start working. Imaging in black-and-white and in color, and in mono and stereo views will aid in selecting the first surface sample site. On SOL-8, the 3.05-meter (10-foot) boom will take the first samples for chemical and biological examination. After delivery of the samples, magnets on the sampling boom will be imaged to determine whether any soil particles have adhered. Within the following few hours, all the instruments will be in full operation.

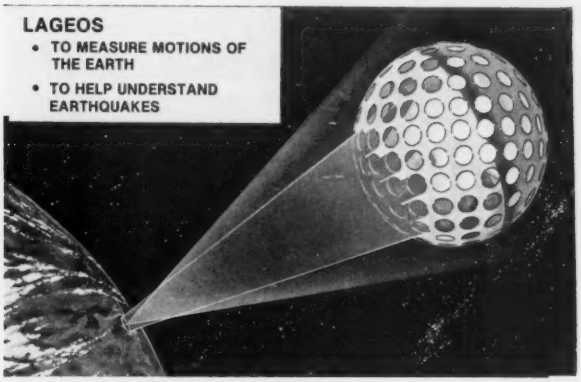
Surface samples will be delivered to three instruments: An X-ray fluorescence spectrometer will perform an elemental analysis for surface composition, a gas-chromatograph-mass spectrometer will analyze its portion of the sample for organic compounds, and the biology instrument will separate its sample into three portions for incubation under three different conditions for possible detection of microorganisms. The three biology cultures will look for evidence of growth, metabolism and photosynthetic activity.

If in the biology investigation the Martian samples respond like those of Earth soil, that response will present a strong argument for the existence of life on Mars. On the other hand, if there is no evidence of activity, the results do not necessarily mean that life is lacking. It could mean that either we sampled at a barren site or that Mars organisms, if they are present, do not respond in the same way as Earth organisms do under the test conditions.

Almost everyone familiar with the history of the exploration of Mars has speculated on what might be discovered by Viking. What is it really like? The world is anxiously awaiting the first answers to that question.

Lageos Is Launched Successfully

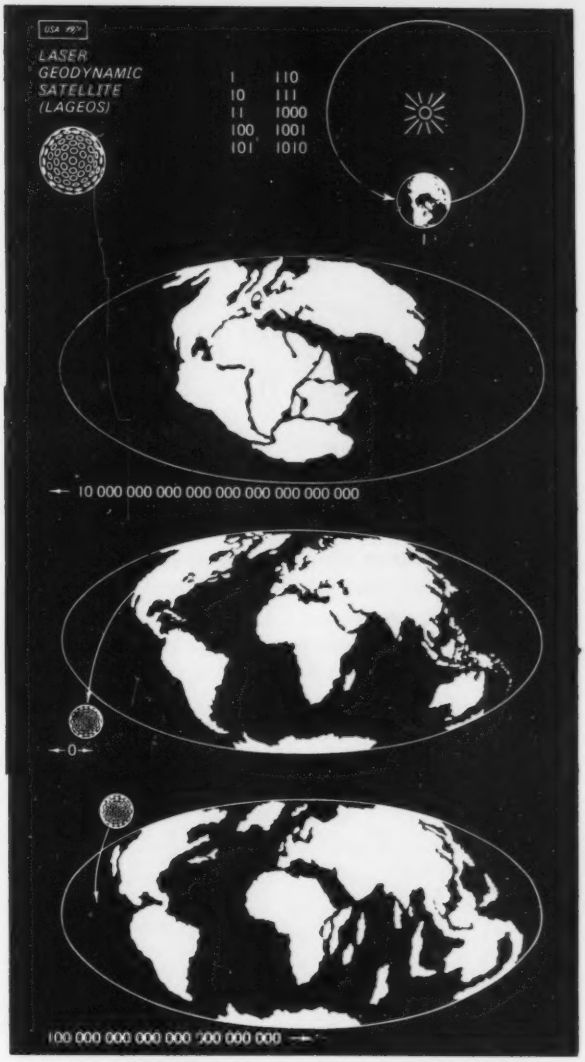
A Laser Geodynamic Satellite that will serve as a tool for obtaining information on Earth's crustal movements, polar motion, solid Earth tides and precise locations of various spots on the planet was launched May 4 from the Western Test Range by a three-stage Delta vehicle. A perfect launch, lighting the sky with liftoff at 3 a.m., the Delta rocket disappeared into overhanging clouds after about eight seconds. Orbital elements generated in the early phase of the mission indicate that the apogee is 5,957 kilometers and the perigee is 5,850 km., with an inclination of 109.8 degrees and a period of 225 minutes.



Built to Last—The recently launched small—60 centimeters (24 inches) in diameter, weight 411 kilograms or 903 pounds—Lageos will remain in orbit for more than eight million years, scientists estimate, though its useful life is only 50 years. Its "dimpled" appearance is the result of an array of 426 prisms that will reflect laster beams. The retroreflectors are made of silica.

Lageos is the first NASA spacecraft dedicated exclusively to laser ranging. A laser pulse beam sent to the satellite from a ground station initiates a timing signal that continues until the pulse beam is received back at the ground station. By measuring the time it takes the beam to make the round trip, scientists will be able to calculate changes in the distance between the satellite and the laser ground station to within a few centimeters. By monitoring this changing distance, minute measurements of movements of large land masses called tectonic plates can be determined and perhaps correlated with observed Earth dynamics phenomena.

The Lageos is an electrically and mechanically inert sphere carrying an array of 426 cube-corner retro-reflectors located in a near symmetical pattern over the entire surface of the sphere. Two aluminum hemispheres bolted together around a brass core provide a large mass/surface ratio to minimize the effects of the solar wind and reduce gravitational distortions. The near circular orbit of about 5,900-km. altitude will allow simultaneous observations between stations on different continents.



A message for the Future—Should future generations sight Lageos in Earth orbit, or puzzle over the satellite when it returns to Earth millions of years hence, a message sealed within will attempt to explain the situation. The first drawing, with the binary system representing the number 1 through 10, shows a diagram of the Sun with the Earth revolving around it in a counterclockwise direction (as the viewer looks down upon the North Pole); the number "1" beneath the Earth means that one revolution represents one Earth year. Second is the geophysical view of how Earth looked some 200 million years ago. Third, the Earth today, showing Lageos being launched from California in a southerly direction (the zero with arrows pointed left and right indicates the present time). Fourth, Earth as geophysicists see it about 10 million years from now. Lageos is shown returning to Earth and the binary numbers with arrow indicate the number of years following the launch of the satellite.

Because there are no active parts, Lageos will give geoscientists a steady reference system from which to measure accurately relative crustal motions of the Earth for many decades. Although the orbital lifetime of Lageos is estimated to be more than 10 million years, its useful life will be limited by the optical degradation of the retroreflectors, estimated to occur between 25 and 50 years from now. The spacecraft was designed, developed and manufactured by NASA's Marshall Space Flight Center.

Sealed inside the Lageos is a message intended to be read by creatures far in the future should the satellite be retrieved from orbit or discovered after its return to Earth some 10 million years hence. The message, prepared by Dr. Carl Sagan of the Laboratory for Planetary Studies at Cornell, is inscribed on two small stainless steel sheets installed at each end of the bolt connecting the two hemispheres that make up Lageos. The inscription displays the simplest counting scheme—binary arithmetic which uses only zeros and ones—a schematic drawing of the Earth in orbit around the Sun, and three maps of the Earth's surface.

The first map shows the approximate configurations of the continents in the Permian period (about 225 million years ago) when they were beginning to separate from the supercontinent known to plate tectonic theorists as "Pangaea." The second map displays the present configuration of the continents and shows Lageos being launched into orbit. The third map shows the predicted positions of the continents about 8.4 million years from now, a figure that represents the estimated lifetime of Lageos. The predictions in the maps are conceptual, not precise, but they should give future discoverers of Lageos an idea of what they have found.

Comstar Satellite in Orbit

Comstar I-A, the first in a series of domestic communications satellites of Comsat General Corp., was successfully launched by an Atlas-Centaur launch vehicle on May 13 from NASA facilities at Cape Canaveral. NASA was reimbursed for vehicle cost and associated support activities by Comsat General, a subsidiary of Communications Satellite Corp.

The spacecraft will be leased by Comsat to the American Telephone and Telegraph Co. as part of a nationwide communications network. Each will have a capacity for more than 14,000 two-way, high-quality voice circuits. The three Comstars planned for the system, when operational, will be capable of providing reliable communications to the 48 contiguous states, Alaska, Hawaii and Puerto Rico. The second Comstar is planned for launch later this year.

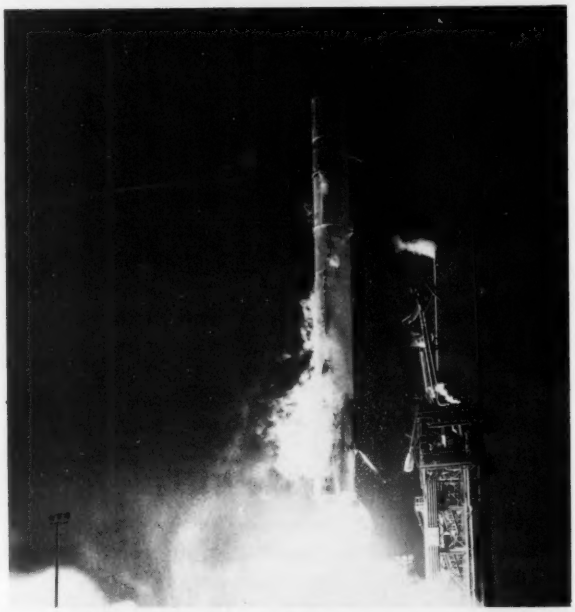
NASA's Lewis Research Center has management responsibility for the Atlas-Centaur development and operation. The Kennedy Space Center is assigned vehicle checkout and launch responsibility once the vehicle reaches the Cape.

Space Processing Applications Rocket Launched

The second in a series of some 15 Space Processing Applications rockets to be launched during the next five years was launched May 17 from the Army's White Sands Missile Range in New Mexico. A Black Brant VC sounding rocket lifted the payload to an altitude of about 188 kilometers (117 miles) and provided about five minutes of near-weightlessness during the coast phase of its suborbital trajectory.

The payload consists of 10 experimental instruments, eight of which used apparatus similar to that carried on the first SPAR launch in December 1975. Two of the experiments were entirely new. The payload was recovered by parachute some 15 minutes after launch and the experiments were delivered to the various principal investigators for post-flight analysis.

These low-cost sounding rocket launches represent a means of obtaining space processing scientific data in near-zero gravity. The Marshall Space Flight Center manages the SPAR project for NASA's Office of Applications. The Goddard Space Flight Center provides the rocket system and directs the launch and payload recovery.



Comstar at Liftoff—The first of three domestic communications satellites of Comsat General Corp. was placed in orbit last May by an Atlas Centaur launch vehicle from Cape Canaveral.

Space Age Blood Pressure Readings

NASA's Office of Occupational Medicine, in cooperation with the Department of Health, Education, and Welfare, during the month of May sponsored a program to promote employee awareness of hypertension as a serious medical problem. The aim of the NASA plan was to screen as many employees as possible during May, even though many might have had a recent physical examination, to obtain an up-to-date record of the extent of the problem among NASA personnel.

Informational literature and promotional materials were developed and distributed to all NASA facilities to assist installation directors and their medical staffs in organizing local programs.

The pilot program at headquarters involved the installation of a portable booth in central locations in each NASA building so that passing employees could stop in for a two-minute check of blood pressure. The booth was staffed with a nurse from the medical facility and was open for blood-pressure screening each afternoon during four work weeks. The booth contained a "space age" automatic blood-pressure measurement device with a digital read-out and an online computer program that provided individual cardiovascular disease risk analyses based on individual profiles. The printout given to each examinee listed his/her blood pressure reading and heart rate, followed by a comment that defined the normal range based on the individual's age, sex, weight and smoking habits. The form included a statement concerning the likelihood of, or the odds against, heart or circulatory disease within an eight-year period. If pressure readings were too high, the printout advised an additional check-out and suggested minor remedies.

Hypertension Factors Monitored—Dr. Harriet Jenkins (left), Assistant Administrator for the Office of Equal Opportunity, was one of many NASA employees to take advantage of a blood-pressure checkup administered by Susan Ashby, a nurse with NASA's health unit. The pilot program, in effect for one month, sought to screen all NASA headquarters personnel and provide information concerning findings related to pressure levels and rate of heartbeat.

Response to the program was exceptionally high. More than 856 employees were screened during the four-week test at headquarters, 400 at the Wallops Flight Center. A number of those was advised to seek additional medical attention.

Medical authorities point out that hypertension, the nation's most common disease, afflicts 23 million Americans or 15 percent of the adult population, but that only half of these are aware of their problem. Although easily and inexpensively detectable, the disease is often not treated because it is usually not accompanied by overt symptoms or feelings of ill health. Estimates are that hypertension and hypertensive heart disease—implicated in strokes, heart attacks and kidney failure—cause some 60,000 deaths annually.

Air Force Satellite Sent Aloft

The Air Force P76-5 satellite was launched successfully on a Scout launch vehicle from the Western Test Range on May 22. The Scout vehicle placed the satellite into a near-circular, sun-synchronous orbit.

The spacecraft is an experimental satellite for the evaluation of certain propagation effects of disturbed plasmas on radar and communications systems. NASA will be reimbursed for costs associated with the provision of the Scout vehicle by the Air Force Systems Command.

Hollywood Spacefarer Visits NASA Headquarters—One of the stars of the television series "Star Trek," Nichelle Nichols ("Lt. Uhuru") is briefed on plans for the launching of the Space Shuttle. Showing a model of the vehicle, scheduled for launch in 1979, is Isaac T. Gillam, Director of Shuttle Operations; looking on is Dr. James King, director of the Office of Upper Atmospheric Research. Asked if she would like to be a crew member of the Space Shuttle when it lifts off, Nichols smiled and said "Why not?"

Employees' Tribute to Dr. Low

Several hundred NASA employes attended a farewell reception at headquarters in honor of Dr. George M. Low, Deputy Administrator, who left the agency in June to become President of Rensselaer Polytechnic Institute.

A tribute from all NASA personnel was delivered which said:

"Employees of the National Aeronautics and Space Administration are proud of the historic role our agency has played in the progress of mankind.

"We are fortunate to have contributed—each in his or her own way—to this nation's remarkable achievements in aeronautics and space. Those achievements have made the United States the leading spacefaring nation of the world. They have permitted man for the first time in history to journey to another celestial body. They are bringing within our grasp answers to age-old questions about humanity and its future. And those achievements are leading us to an era when the vantage point of space will be used routinely for the benefit of all mankind.

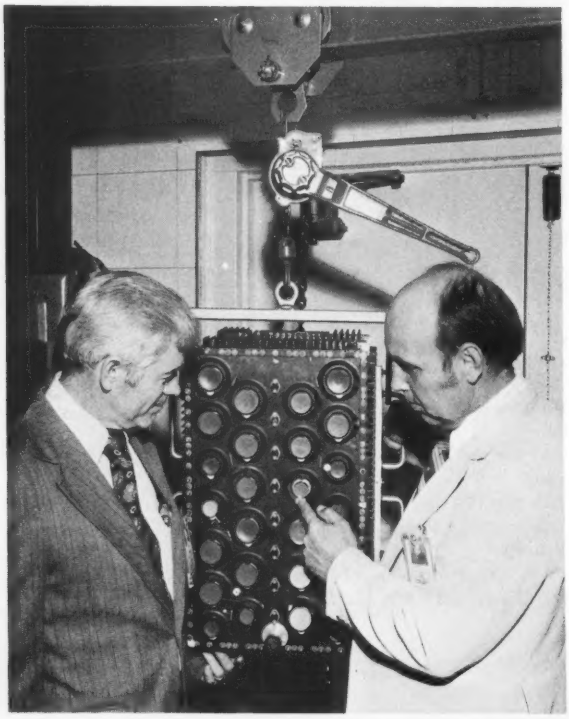
"But the accomplishments that NASA is noted for did not just *happen*. They are the result of the efforts of literally hundreds of thousands of persons who worked on NASA programs—in Government, in industry and in universities. And, just as important, our accomplishments are the result of dedicated and effective leadership—leadership as exemplified by the man we honor today, Dr. George M. Low, NASA's Deputy Administrator.

"If any one person deserves special credit for the Apollo program and the scientific results of that program, that person is Dr. Low. Equally important, if any one person at NASA deserves recognition for the human qualities of our agency, that man too is Dr. Low.

"Dr. George Low believes that you can solve any problem if you put your mind to it. He is quoted as saying that from the time he first learned what an engineer was, he wanted to be one. His first memories are of taking apart and putting together machinery on his father's farm in Angern, Austria, 25 miles outside Vienna, where he was born in 1926.

"Dr. Low came to this country in 1940 and became a naturalized citizen in 1945, shortly before he went into the U.S. Army. He had already completed three years at Rensselaer Polytechnic Institute. In 1946 he was discharged and returned to Rensselaer, where he received a degree of Bachelor of Aeronautical Engineering in 1948 and a degree of Master of Science in Aeronautical Engineering in 1950. During his last year on campus, he married Mary R. McNamara of Troy, New York. (Anyone who knows 'Mary R.,' as she is called, appreciates fully the reason that a recent editorial welcoming Dr. Low back to Rensselaer was entitled 'Welcome Back Mary R'.)

"Dr. Low joined the National Advisory Committee for Aeronautics, NASA's predecessor agency, in 1949 and



A Piece of the Space Shuttle Action—A "controller" for the Space Shuttle Main Engine was delivered to NASA's Marshall Space Flight Center, which is responsible for SSME development, in late May. It will be integrated with other computer equipment and engine hardware practical for use indoors in the hardware simulation laboratory. The set-up, when complete, will be used in full simulation of engine firings. The controller, itself a type of computer, will control all functions of the SSME, including start and stop commands, throttling, propellant flow, redundancy switching and emergency cutoff. The simulated firings are designed to check out computer software and evaluate the performance of engine hardware. This controller will serve as a backup controller for actual engine firings at the National Space Technology Laboratories if needed. The unit is manufactured by Honeywell, Inc., a subcontractor to Rockwell International, whose Rocketdyne Division is prime contractor for the SSME. Here Zack Thompson (left) and H. G. Vick of MSFC examine the controller.

has been with NACA/NASA since then. When NASA was formed in 1958, Dr. Low was a leader among the young engineers who knew that their bold visions of space flight could and should be translated into national programs. As Chief of Manned Space Flight and later as Assistant Director for Manned Space Flight Programs at headquarters, Dr. Low was responsible for the overall direction of the Mercury and Gemini programs, and he chaired the group that planned the lunar landing mission. His work in the early days of NASA provided the scientific and technological foundation for President Kennedy's commitment in 1961 to a manned lunar landing.

"In 1964, Dr. Low became the Deputy Director and General Manager of the Manned Spacecraft Center (now the Johnson Space Center). Following the tragic Apollo 204 fire, he assumed the mammoth job of reestablishing and motivating the Apollo management team.

"Throughout Dr. Low's 27 years at NASA, he always seemed to work harder than the rest of us and to contribute more than his share to whatever he was involved in. But if there was any one assignment that pressed his abilities and dedication, it was Dr. Low's personal contribution to the historic success of Apollo. Even in the aerospace business, where rigor and precision are hallmarks, Dr. Low's demands on himself and his colleagues are legendary among us. As Apollo Program Manager, he and his team reexamined literally every facet of the Apollo spacecraft and established goals and timetables that initially looked impossible to achieve. But during these difficult times, his good humor and his inherent fairness and kindness combined with his let's-get-the-job-done attitude to motivate all levels of the Apollo program so that we did indeed achieve the impossible.

"His efforts in rebuilding the Apollo spacecraft led to the first manned flight of Apollo in October 1968 followed in December 1968 by the Apollo 8 mission, the world's first manned lunar flight. Characteristically, it was Dr. Low who provided the original concept of a lunar orbit mission to extend the capability of the redesigned spacecraft.

"He developed the flight test program that led to the first manned lunar landing on July 20, 1969, and at the same time contributed greatly to the Apollo science program that paved the way for the extraordinary Apollo scientific achievements.

"In November 1969, Dr. Low was appointed Deputy Administrator, and less than a year later he personally instituted negotiations with the USSR that resulted in the successful Apollo-Soyuz Test Project last year.

"From the time he became Deputy Administrator, he has worked hard to assure a smooth transition from the first generation of space flight—the era of Mercury, Gemini, and Apollo—to the post-Apollo era with reordered priorities and major emphasis on getting the most out of space on a tight budget.

"He personally took charge of NASA's efforts to increase the opportunity for females and minorities to participate at all levels in NASA programs. And he has been deeply involved in assuring that NASA remains an agency where talented young scientists, engineers, and administrators are given career opportunities to develop to their fullest.

"Dr. Low has been widely recognized and honored outside of NASA for his truly outstanding Government career. Among his many awards are the Arthur S. Flemming Award, the National Space Club's Goddard Memorial Trophy, the National Civil Service League's Career Service Award, and the Rockefeller Public Service Award. Within NASA, Dr. Low has received its Outstanding Leadership Metal and two Distinguished Service Medals.

"But more than these, within NASA Dr. Low has earned the confidence, admiration, and affection of NASA employees throughout the agency. He is universally recognized as a hardworking and effective leader and manager, and a kind, gentle and sincere person.

"We thank you, Dr. George Low, for helping us to become the first-rate agency we are and for showing us how to achieve great things. We wish you the very best in your new career at Rensselaer."

Engineering Award—Billy T. Sumner (left), president of the American Consulting Engineers Council, presents his organization's special bicentennial "Amicus Award" to John F. Yardley, NASA Associate Administrator for Space Flight, who accepted on behalf of Administrator James C. Fletcher. The award, given on May 21 at the Council's annual convention, was in recognition of NASA's "outstanding contributions to the engineering profession and to the nation."

The Search for Life on Mars

Sagan

Editor's Note: Dr. Carl Sagan, professor of astronomy and space sciences and director of the Laboratory for Planetary Studies at Cornell University, has prepared six articles for NASA concerning the 1976 Viking mission to Mars. Sagan serves on the lander imaging and landing site selection teams for Viking. He is a recognized leader in the international space science effort and the winner of numerous awards for his many contributions to interplanetary research. The first of the six articles follows.

Legend has it that some 50 years ago a celebrated newspaper publisher sent this telegram to a famous astronomer: "Wire collect immediately," the telegram demanded, "500 words on whether there is life on Mars." The astronomer dutifully replied 250 times: "Nobody knows, nobody knows, nobody knows, . . ." But despite this confession of ignorance asserted with dogged persistence by an expert, no one paid any attention; and, from that time to this, we hear authoritative pronouncements by those who think they have deduced life on Mars and by those who think they have excluded it.

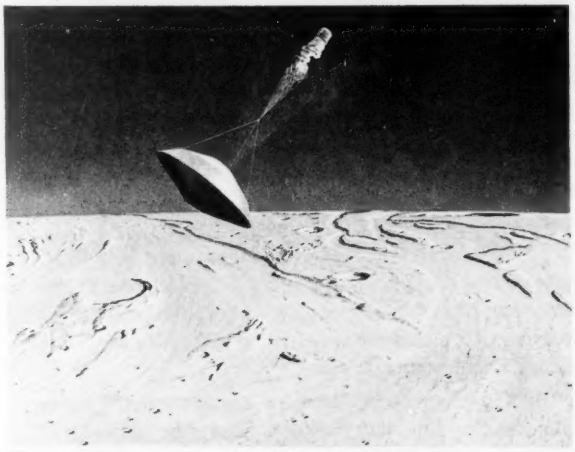
The first purported evidence of life on Mars came almost exactly a century ago, in 1877, when an Italian astronomer, Giovanni Schiaparelli, peering at Mars through a new telescope outside of Milan and at a time when Mars was close to the Earth, saw to his astonishment a network of single and double straight lines which seemed to criss-cross the planet, "like the lines on a fine steel etching.'" Schiaparelli named them *canali*, which in Italian means channels or grooves. The word was promptly mistranslated into English as canals, a name by which they have been known ever since.

The American astronomer, Percival Lowell, was entranced by what he believed was the explanation of the canals, and erected a major observatory and devoted his life to the problem. The canals of Mars, Lowell eloquently argued, were canals: an intricate network of waterways constructed by a race of hydraulic engineers in a planet-wide water conservation project. The idea of a noble species of dedicated engineers gamely surviving through their technical ingenuity on an increasingly arid planet caught the romantic imagination of the public, particularly after it passed into popular fiction in the works of Edgar Rice Burroughs and others.

The only trouble is that the canals of Mars do not exist. The Mariner 9 spacecraft orbited Mars for a full year in 1971-72, and photographed the planet pole to pole with a discrimination of fine detail 100 times better than the astronomers of Lowell's time could possibly have managed. Mariner 9 was only 1,600 kilometers (1,000 miles) from the Martian surface compared with the 40 million kilometers (25 million miles) which separate Earth and Mars at their closest approach, and Mariner 9 did not have to look through the ocean of air which hampers astronomical observations from the surface of our planet.

A few of the canals may be great rift valleys, or the accidental alignment of impact craters, or linear streaks of dark dust; but no canal network as described by Schiaparelli and Lowell exists on Mars and the most generous assessment of the "canal problem" is to mark it down to the imprecision of the human hand-eye-brain combination: The canals were drawn at the telescope during brief moments of relative steadiness of the Earth's turbulent atmosphere.

Likewise, astronomers of Lowell's time observed seasonal changes, an increasing contrast and a sharpening of boundaries between adjacent bright and dark markings on the planet's surface. Some also reported color changes. These variations were called the "wave of darkening," which was reported to move from the shrinking polar cap in early spring towards and across the equator in the summer. Lowell and others attributed these seasonal changes to the growth and proliferation of Martian plants imagined to constitute the dark areas, and likened the wave of darkening to the sprouting of vegetation and the growth of leaves on deciduous trees in the Earth's Northern Hemisphere. Again Mariner 9 has dampened this interesting idea. Close observations have shown that the changes almost certainly are due to the redistribution of bright and dark dust by Martian winds, varying with the seasons.



Close to Contact—How the Viking lander may look as it heads for a touch down on the plains of Chryse, Mars, some 6,666 meters (20,000 feet) above the Martian surface.

A number of other supposed proofs of life on Mars—the "green" color of the dark areas, the reappearance of the dark areas after being covered by bright powder duing a Martian dust storm, and the supposedly anomalous motion of the innermost moon of Mars—all turn out to have other explanations. Is life on Mars therefore excluded? Not at all. Mars is certainly colder than the Earth, it has a thinner atmosphere, less oxygen, less ozone (ultraviolet light from the Sun reaches the surface of the planet) and no abundant liquid water. These are environmental conditions which would instantly kill an unprotected human being on Mars. But life is not the same as human life and a wide variety of terrestrial microorganisms is able to survive indefinitely under Martian conditions, and if they are provided, even briefly, with a little liquid water they are able to reproduce. Since terrestrial microbes which have evolved on the Earth are able to survive and possibly grow under Martian conditions, Martian organisms, if any, should be much better adapted to the apparent inclemencies of the Martian environment.

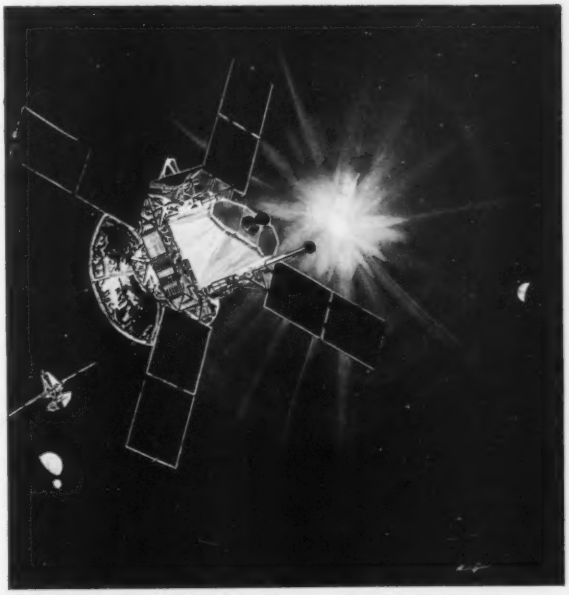
For some reason it is thought to be a sign of caution to admit the possibility of microbes on Mars but to exclude peremptorily the possibility of macrobes—organisms large enough for us to see without mechanical aids were we on Mars. But there seems to be no evidence for or against Martian macrobes, and, for all we know, there is a thriving population of large organisms on the planet. Nothing in our present understanding of Mars excludes this possibility. A hundred thousand years ago the Earth was burgeoning with life—indeed because the number of humans was still small, there was then a much richer variety of organisms than there is today. But had Mariner 9 been put into orbit about the Earth a hundred thousand years ago, it would have been able to photograph no clear signs of life whatever. Today the situation is different because human engineering enterprises, both urban and agricultural, have remade the landscape of the Earth.

Mars today might have a dense population of varied and robust organisms, both microbes and macrobes. If so, we have no way of predicting what those organisms are like except that evolution seems clearly to imply that they would not closely resemble the organisms of Earth—they have spent too long adapting to an extremely different environment to be much like us. Mars might have life which is tenuously hanging on in a world enveloped in what looks very much like an ice age. Perhaps there are spores and hibernating forms awaiting the return of more Earth-like conditions; or perhaps there is no life at all, but only fossils and other signs of a now-extinct biology. Alternatively, Mars might be lifeless today and lifeless in the past. We simply do not know which of these circumstances characterizes the planet.

But any one of these speculations is of substantial interest. If Mars has now or ever had living things, we will have for the first time in human history an opportunity to test the generality of the process which on Earth we call life. We will be able to determine how different from Earthly organisms life can be. Whatever form of life exists on Mars, its implications for biology and for our view of ourselves would be breathtaking—because if life has independently arisen on two rather different adjacent planets, the argument that life is commonplace in the Milky Way Galaxy will become almost compelling. If on the other hand Mars proves to be lifeless, we have the classic scientific situation, the experiment and the control. We will then be able to approach the important question of why life arose on the Earth but did not on Mars. The answer to that question is bound to illuminate profoundly our understanding of the origin of life.

Fortunately, the epoch of ambiguity about Martian biology, the time when the only responsible answer is "nobody knows," is drawing to an end. Because in the summer of 1976, if all goes well, two exquisitely instrumented landing capsules called Viking will land on the Martian surface, there to search directly for the possibility of life.

Dr. Sagan is scheduled to speak at NASA headquarters in the Administrator's "Profiles of the Future" Colloquium on Aug. 4, from 3:00 to 4:00 p.m., in the FOB-6 auditorium. His topic will be "The Chance of Life Elsewhere."



The Two Vikings in Flight—How an artist sees the two spacecraft as they travel on a 736-million-kilometer (460-million-mile) journey through space to Mars. Earth and Moon are at lower left, Mars at mid-right.

Black Universities Chosen for New Project

Two predominantly black universities, Tennessee State and Tuskegee Institute, have been selected as participants in a new project to be carried out at NASA's Lewis Research Center. The project, underway since June, is called "Minority Involvement in NASA Engineering," or MINE. Six universities were under consideration as participants in MINE, which is aimed at developing a wide variety of programs and activities of benefit to the Lewis center and the universities.

The two universities chosen will receive grants for the pursuit of research and technology projects relevant to NASA's mission. Specifically, MINE calls for Lewis to assemble continuing NASA-university affairs programs; to furnish instructors and lecturers; and to permit the universities to use surplus government equipment as well as the Lewis research facilities.

Lewis center engineers Harrison Allen, Jr., and Lonnie Reid, a graduate of Tennesse State, are program managers at the Lewis center. Allen, who is assistant chief of the Technology Utilization Office, said:

"In implementing the project at the universities, we will try to make the challenges and opportunities of careers in science and engineering better known to minority and women students and at the same time strengthen these universities in fields of technology."

New Appointment at Marshall

O'Dell

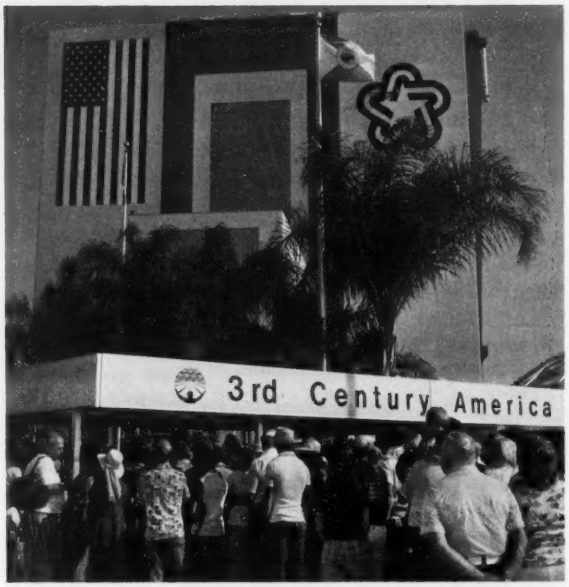
Dr. C. Robert O'Dell recently was named associate director for science at the Marshall Space Flight Center. He succeeds Dr. Ernst Stuhlinger, who retired in late 1975. Dr. O'Dell, a prominent astronomer, joined the center as associate director for astronomy in the Science and Engineering Directorate in 1972. He will continue as project scientist for the Space Telescope Project in addition to fulfilling his new role.

The Nation's Life Style on Display

"Third Century America," the Government-sponsored Bicentennial Exposition on Science and Technology, opened to enthusiastic crowds on May 30. No admission fees were charged on opening day.

The huge exhibit, which sprawls over 30 acres at the Kennedy Space Center, shows visitors—in innumerable ways—how science and technology have affected everyday life in the past and present, and how they may help shape future life in this nation.

So numerous are the exhibits and exhibitors that only a sample listing of the many attractions is possible. Sixteen Federal agencies, ten industrial firms and a number of universities and colleges are taking part in the educational, entertaining, sometimes spectacular displays; special events include concerts, aerial and parachuting demonstrations; an international conference will be held, dealing with the setting of goals for third century America; and special ceremonies will be held to honor States and Federal agencies.



Third Century America—On the first day of the Bicentennial Exposition on Science and Technology at the Kennedy Space Center, visitors flock at the gates.

A partial listing of offerings by some of the sponsors follows.

- **Agriculture** demonstrates how we must boost food production to match population increases; how agricultural land is used; cattle-rearing techniques; pest control measures; forestry; and solar energy research.
- **American Revolution Bicentennial Administration** traces in words, pictures, sound and films the story of this nation's first 200 years.
- **National Endowment for the Arts** shows a living sculpture created with high-intensity laser rays and shafts of natural sunlight shining through mirrors, prisms and water. Visitors move through the light structure, thus themselves becoming part of the work
- **Commerce's National Oceanic and Atmospheric Administration** highlights a 100-ton oceangoing environmental buoy packed with sensors for the collection of information about the weather and the oceans. The information is radioed by unattended instruments via satellite relay to shore stations for the benefit of many kinds of users. **Commerce's Bureau of Standards** shows how to understand the metric system.

• **Community Services Administration** explains the motivation and operation of major social and anti-poverty programs.

• **Department of Defense** shows how several of its components exert a strong influence on a wide variety of research and technology that touches many facets of everyday life. Examples include food handling, communications, the atmosphere, air and ground transportation, energy and life-saving innovations.

• **Energy Research and Development Administration** features solar-operated TV sets, "you-drive" automobiles operated by experimental gas-turbine and electric engines, and energy-related live and motion-picture presentations.

• **Environmental Protection Agency** tells of our rich legacy of abundant natural resources, the contributions they have made and will continue to make to national well-being, and how science and technology can contribute solutions to problems that threaten natural resources.

VAB Houses Many Exhibits—The Vehicle Assembly Building is crowded with KSC employees and their families the day before the Bicentennial event began.

Industrial Exhibitor—The TRW, Inc. display at the Bicentennial Exposition shows how space R&D technology has carried over into other fields on Earth, for the benefit of humanity.

• **Health, Education and Welfare** chooses the theme "Freedom from Dependence" to illustrate the many medical advances made through technology, how technology has aided in medical diagnoses, treatment and instrumentation, and how technology and preventive medicine combine to provide better health and longer lives. Tests for hypertension and other problems are administered at no charge.

• **Housing and Urban Development** features an animated cartoon figure that discusses happenings in the nation's communities in conjunction with audio-visual displays.

• **Interior** shows films and displays centered on water, energy, minerals, recycling, people, recreation mapping, the outer continental shelf, and the land. **Interior's Fish and Wildlife Service** offers tours of the nearby Merritt Island National Wildlife Refuge.

Not a Bird, Not Superman—A member of the U.S. Army's Golden Knights parachute team soars over the Kenendy Space Center as part of one of the events that takes place at the Bicentennial Exposition.

• **NASA's** offerings include: a "Spaceport of Fun," in which visitors can amuse themselves while learning about space by operating various space vehicles and demonstration devices; an exhibit produced through the cooperative efforts of four NASA field offices, of solar power systems, space colonies, industrial applications and other developments with futuristic connotations that are expected to affect human life; an aeronautics display concentrating on the changes and advances in store in the fields of propulsion, flight controls and structures, fuel consumption, aircraft construction, and noise control; a dramatic re-creation of the launch of Apollo 11 on man's first journey to the Moon; a display of exact replicas of Apollo Soyuz Test Project spacecraft; multiple exhibits showing how ordinary life has been made better by spin-offs from space programs; a full-scale model of Spacelab; an exhibit devoted to Space Shuttle concepts; a design concept of the Space Telescope; displays of space technology utilization in the fields of medicine, recreation, housing and transportation; spacecraft tracking systems; and a full-scale operating model of the Viking lander with a demonstration of its role in the Viking mission to Mars.

• **The National Science Foundation** uses films and exhibits to tell the story of "Earth, Air, Fire and Water" from a scientific standpoint.

• **U.S. Postal Service** sponsors a philatelic retail sales station for the purchase of a large selection of Bicentennial issue stamps and other postal products and services.

• **Transportation** shows numerous types of air, land and water vehicles and equipment designed to make life safer, more pleasant, or more profitable for travelers and commercial interests.

• **Treasury** allows visitors to strike their own bronze Bicentennial commemorative coins for a small fee.

• **Industry** exhibits encompass a wide range of subjects including aerospace, computers, electronics, motor vehicles, oceans, solar power, space and defense, and space exploration. Firms represented are: E Systems, Inc.; General Dynamics; Grumman Aerospace Corp.; International Business Machines Corp.; Lockheed Missiles and Space Co.; McDonnell Douglas Astronautics Co.; Rockwell International; Thiokol; TRW Defense and Space Systems Group; and United Technologies Corporation.

The exposition closes on Labor Day.

Bemused Little Space Buff—Young visitors to the KSC Spaceport of Fun can participate in the final moments of a launch countdown at the exposition in the VAB.

Heads Up—Visitors to Third Century America walk under a huge mobile launcher, one of the many space features on display at the KSC-hosted exposition.

Navy Capt. Weitz Becomes Civilian

Astronaut Paul J. Weitz retired from military service in June after 22 years in the U.S. Navy. He will remain with NASA in his present job at the Johnson Space Center, working on payloads and flight crew documentation for the Space Shuttle program.

Weitz, one of the 19 astronauts selected by NASA in April 1966, piloted Skylab 2 on a 28-day flight in 1973. With astronauts Charles Conrad, Jr., and Joseph P. Kerwin, he helped to erect a "parasol" shade, saving Skylab from possible disaster by alleviating a thermal problem caused by the loss of the micrometeoroid shield. The three also were able to deploy a jammed solar power wing to assure sufficient electrical power to successfully conduct their mission and two follow-on missions of 59 and 84 days respectively.

New NASA Assistant Administrator Named

Evans

Rear Admiral Stuart J. Evans recently became NASA's Assistant Administrator for Procurement, succeeding Kenneth L. Woodfin. Evans retired from the Navy in late May. His last Navy assignment was as Deputy Chief of Naval Procurement.

Evans earned his B.S. degree from the Naval Academy in 1946, was graduated from the U.S. Naval War College in 1961 and from the Industrial College of the Armed Forces in 1968. He received a master's degree in business administration from Stanford University in 1954. He served in a number of positions involving procurement while with the Navy.

Evans was awarded the Legion of Merit twice for Navy service, once in 1972 and once in 1975.

Huge Parachutes to Be Tested

The parachute system for the Space Shuttle solid rocket booster will be evaluated in a test program to be undertaken by NASA's Marshall Space Flight Center and the Dryden Flight Research Center.

The parachutes, some 36.5 meters (120 feet) in diameter, are the largest ever used in the space program. The parachutes used in the Apollo program were about 24.5 (80 ft.) in diameter.

The Space Shuttle, the primary vehicle for the Space Transportation System of the 1980s, will emphasize the reusability of most of its components—the orbiter, main engines and solid rocket boosters.

When the Shuttle flies, two solid rocket boosters will be used for each launch. They will fire together with the orbiter's three main engines to boost the vehicle from the launch pad to an altitude of about 43.5 kilometers (27 miles).

The solid rocket boosters, largest ever flown, then will be jettisoned at burnout for descent by parachute to the ocean about 225 km. (140 mi.) downrange. The boosters will be recovered, towed back to shore, refurbished, refueled and prepared for reuse.

The test series, to begin in early 1977, will consist of drogue parachute tests and main parachute tests, most of which will use only one main parachute.

Test deployment of the cluster of three main parachutes—the actual flight configuration—also will be included. Inasmuch as the test vehicle weighs about one-third of actual booster weight (22,680 kilograms or 50,000 pounds), it will approximate flight conditions. The drops will be made from a B-52 aircraft over the National Parachute Test Range, one hour's flight from Edwards Air Force Base. The Dryden center will provide the aircraft, the flight and maintenance crews, and will perform the drop tests over the range. Data will be evaluated by Marshall center engineers to determine the adequacy of the recovery system.

The test vehicle will be designed by the parachute contractor, not yet selected, who also will furnish the parachute test specimens.

Dry Run in Orbiter—Shuttle commander Joe Engle briefs Congresswoman Yvonne Burke of California while seated in the cockpit of the Shuttle Orbiter. Burke and other members of the House Appropriations Committee viewed the Orbiter at Rockwell International's Palmdale, Calif. facility and then toured the Hugh L. Dryden Flight Research Center at Edwards. The group was briefed on current Dryden center projects.

PROSPECTUS

The second in a series of articles written for NASA Activities *continues to explore NASA's origins as our Federal government's major research and development agency.*

On October 4, 1957, the world was informed by Radio Moscow that a Soviet Earth satellite had been placed into orbit. Within a few hours, the "beep-beep" signals from Sputnik I were being picked up. The reaction among most of the world's peoples was wonder, in the United States a sense of surprise and a feeling of dismay.

In late November, Congress rallied to cope with Russia's scientific master stroke and to investigate the U.S. missile and space program. Following preliminary committe reports, the Senate created a Special Committee on Space and Aeronautics, chaired by Lyndon B. Johnson of Texas, on Feb. 6, 1958. The House formed a similar panel and on March 5, President Eisenhower approved the recommendation of an advisory group that a civilian space agency be established upon the structure of the National Advisory Committee for Aeronautics. The President then sent a space agency bill to Congress.

The pressure behind the legislation was reflected in a May 21 statement by the House Select Committee on Astronautics and Space Exploration, "the establishment of a national space program is a matter of highest urgency both for reasons of immediate national defense and to insure that, in the long run, outer space is effectively utilized for peaceful purposes. The United States is behind the Soviet Union today in its ability to use outer space, and only much hard work and intelligent planning and organization will overcome the lag in the years ahead." The Committee concluded that "national space policy is too important to leave exclusively to military authorities or to scientists alone."

Both Houses of Congress acted quickly and passed the National Aeronautics and Space Act of 1958. President Eisenhower signed it on July 29. NASA was formed.

The Space Act laid down the basic objectives or goals of the U.S. in the conquest of space. It said that American aeronautical and space objectives would be conducted so as to contribute to one or more of the following national goals:

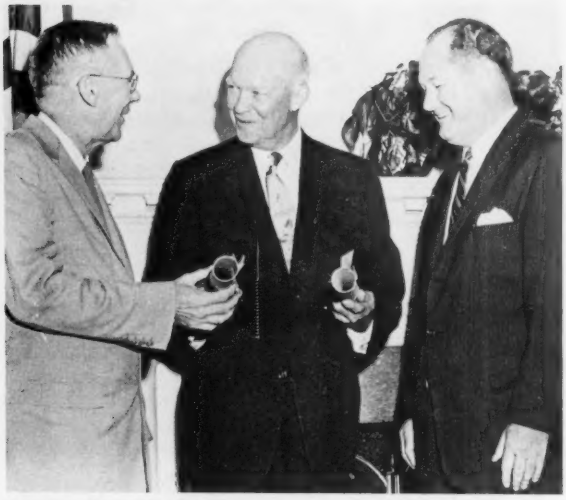
- the expansion of human knowledge of phenomena in the atmosphere and space;
- the improvement of the usefulness, performance, speed, safety and efficiency of aeronautical and space vehicles;
- the development and operation of vehicles capable of carrying instruments, equipment, supplies and living organisms through space;
- the establishment of long-range studies of the potential benefits to be gained from, the opportunities for, and the problems involved in the utilization of aeronautical and space activities for peaceful and scientific purposes;
- the preservation of the role of the U.S. as a leader in aeronautical and space science and technology, and in the application thereof to the conduct of peaceful activities within and outside the atmosphere;
- the making available to agencies directly concerned with national defense of discoveries that have military value or significance and the furnishing by such agencies —to the civilian agency established to direct and control nonmilitary aeronautical and space activities—of information as to discoveries with value or significance to that agency;
- cooperation by the U.S. with other nations and groups of nations in work done pursuant to the Act and in the peaceful applications of the results thereof; and
- the most effective utilization of the scientific and engineering resources of the U.S., with close cooperation among all interested agencies of the U.S., to avoid unnecessary duplication of effort, facilities and equipment.

With the new agency launched, President Eisenhower moved swiftly to commission its hierarchy. He named Dr. T. Keith Glennan, former AEC head, as NASA Administrator; and Dr. Hugh L. Dryden, Director of NACA, as his Deputy. Under their leadership, the U.S. began getting its own hardware into orbit, beginning with Pioneer I in October of 1958, followed by an orbiting Atlas in December. America's unmanned space projects were underway.

For the next two years, the U.S. and the U.S.S.R. filled the corridors of space with their satellites. The world questioned who was superior in technical development. Dr. Glennan answered in part, "We are behind the Russians in total thrust available to us . . . in all other areas, it is my considered opinion that we are not behind, that we are equal or better."

The Soviets, however, retained their imagery as leaders. On April 12, 1961, Yuri Gagarin flew into orbit, exulting to ground receivers that he was the first man in space. Within a month after the cosmonaut's exploit, the American decision had been made and was announced by President John F. Kennedy—to land a man on the Moon and return him safely to Earth by the end of the decade. Project Mercury, approved in the first week of NASA's existence, would provide the initial step.

Three weeks after the Gagarin flight, on May 5, 1961, the beaches of Cape Canaveral were lined with automobiles jammed with people. They looked like the average crowd at a Daytona auto race. But they were watching across the water a small Mercury spacecraft, poised on the NASA launch pad. Car radios gave the countdown. At liftoff, with a gush of flame, the Redstone rocket began to rise. The watchers on the beach began yelling like football fans: "Get up there . . . go, Shepard." And the Mercury rocketed to an altitude of 116.5 miles, attaining a speed of 5,180 miles per hour, in a suborbital flight that ended 15 minutes later in an Atlantic splashdown. Alan B. Shepard, Jr., of the Navy had become the first U.S. astronaut to shake the bonds of Earth. The Moon lay ahead.



A New Agency Is Born—On Aug. 19, 1958, President Eisenhower presented T. Keith Glennan (right) and Dr. Hugh L. Dryden with their commissions of office—Glennan as NASA's first Administrator, Dryden as Deputy Administrator.

NASA 1976 Bond Sales Again Increase

An agency-wide participation rate of 76.4 percent in purchases of U.S. Savings Bonds by NASA employees resulted in a 3-plus percent increase for 1976. New buyers amounted to 756.

Four field installations exceeded the campaign goal of 80 percent: the Kennedy Space Center at 92.7 percent participation; the National Space Technology Laboratories at 89.9 percent; the Langley Research Center at 86.5 percent; and the Johnson Space Center at 80.1 percent.

Not only was there a gain in new subscribers, there was an increase in pledges by 873 of the existing subscribers Net increase will result in additional allotments to bond savings of more than $617,000 annually.

The KSC, for the ninth consecutive year a participant at 90 percent or more of the annual goal, will be awarded a Treasury Minuteman flag with appropriate gold and white service stars in recognition of its achievement. Langley, JSC, Ames and Wallops, all of which participated at a rate of 75 percent of more, also will receive a Treasury Minuteman flag.

Dryden Center Employee Defines Math Formula

Hedgley

David R. Hedgley, Jr., of the Dryden Flight Research Center recently had his first Technical Report published (NASA TR R-458). Such publication is reserved for material displaying the highest level of scientific and technical excellence. Hedgley's paper—"An Exact Transformation from Geocentric to Geodetic Coordinates for NonZero Altitudes"—determines the exact position of a target such as an aircraft, a ship, or a spacecraft in terms of geodetic coordinates consisting of latitude, longitude and altitude.

Hedgley's mathematical formula replaces the existing equations (which are approximations) used in tracking and navigation. The formula also can be used as a standard for evaluating the relative effectiveness of the approximate methods presently in use.

A Dryden center employee for the past decade, Hedgley is center consultant and adviser in applied and pure mathematics and computer science. He also serves as technical assistant to the director of data systems at the center.

Hedgley received his B.S. degree in biology from Virginia Union University in Richmond, his M.S. degree in pure mathematics from California State University at Northridge.

Help for Developing Countries from Spacecraft

A three-month demonstration of how space and other advanced technologies can be used to benefit the people of developing countries will be undertaken jointly by NASA and the Agency for International Development, beginning Aug. 1.

Plans for the demonstration, employing NASA's most advanced communications satellite, ATS-6—otherwise known as the "Teacher in the Sky"—were announced recently by AID Administrator Daniel Parker and NASA Administrator James C. Fletcher. The experiment will demonstrate how the application of space communications, remote sensing from earth resources satellites and high-resolution aerial photography can help some of the world's poorest people boost food production, improve health and nutrition, expand family planning projects and raise income levels. As many as 30 developing countries in Asia, Africa and Latin America are expected to participate in the project. AID is providing $3 million to finance the demonstration.

The project is the first step toward fulfilling a pledge made by the United States to help developing countries improve their economies with advanced technology.

Secretary of State Henry A. Kissinger, addressing the U.N. Conference on Trade and Development in Nairobi, Kenya, last May, emphasized the value of satellite technology in improving cooperation between industrialized and developing nations. AID's Parker said that, depending on the response to the demonstration, AID would be prepared to propose a long-range, follow-up technology program to the Congress.

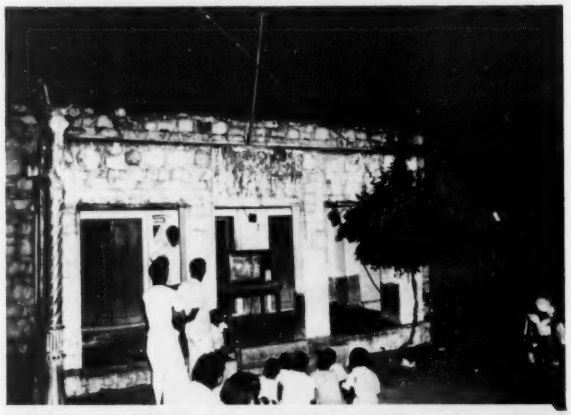
ATS-6 will beam audio or audio-visual presentations, both live and filmed, to special receivers on the ground, including remote areas. Plans call for setting up one transmitter/receiver unit in the capital of each participating country and up to five receivers in outlying locations. Color television monitors will be provided for each receiver terminal site.

The programs in the demonstration project will feature a live two-way discussion between U.S. personalities and representatives of the countries receiving the program. The filmed portion will show material involving communications technologies, remote sensing satellite capabilities and high-resolution aerial photography. Various applications of these capabilities in associaton wth other technologies will be featured to indicate the applications of these resources to the problems of the poor.

The demonstration program also will show films illustrating how the NASA remote sensing satellite, Landsat, is being used in developing countries—to facilitate range management in Africa's Sahel, to locate pure water in Kenya, to inventory forests in Thailand, to identify new land formations in Bangladesh, to pinpoint iron ore deposits in Egypt and to efficiently plan highway routes in Iran and Bolivia.

The program will demonstrate how aerial photography can aid in disaster relief, disaster assessment and prediction of certain kinds of catastrophies such as earthquakes, volcanic eruptions and severe storms.

Under its contract with AID, NASA will move the required transmitter and receiver equipment from country to country, and NASA technicians will be responsible for the operation of the satellite and associated equipment.



East Indian Folk Watch TV Beamed via Satellite—The ATS-6 satellite ("Teacher in the Sky") was loaned to the Indian government for a year for use as a transmission point for information on family planning, farming, nutrition and health measures into remote villages. When the year is up at the end of July 1976, NASA will move the satellite westward for the AID-NASA experimental program.

Veteran Astronaut to Stay with NASA

Ronald E. Evans (Captain USN) recently retired from the U.S. Navy after 21 years of service, but will remain with the space agency. He works at the Johnson Space Center on the operational aspects of the launch phase of the first orbital flight of the Space Shuttle.

Evans began his NASA career in April 1966, serving as a member of the astronaut support crews of Apollo 7 and 11 flights and as backup command module pilot for Apollo 14. He was command module pilot in December 1972 on Apollo 17, the last manned flight to the Moon. He also served as backup command module pilot for the Apollo Soyuz Test Project in 1975.

American Indian Professional Organization

The formation of an organization of practicing American Indian engineers was announced recently at a NASA Equal Employment Opportunity quarterly meeting held at the National Space Technology Laboratories.

Jerry Elliott (an Osage Indian), an engineer with

NASA at the Johnson Space Center and one of the founding directors of the new National Society of American Indian Engineers, made the announcement on behalf of George Thomas, director of the society. Thomas is director of Indian Programs at Oklahoma University.

The society, incorporated last April, has a board of directors and a membership of some 25 persons. NSAIE representatives said the organization was formed to encourage better educational opportunities and funding for minority programs, pointing out that the American Indian community in the United States has few professional societies and only about 1,500 engineers.

Society officials hope to provide a forum for the exchange of ideas and information of mutual interest to youthful would-be engineers and others of Indian descent. Those interested in joining NSAIE may write to George Thomas, Director of Indian Programs, University of Oklahoma College of Engineering, 202 West Boyd St., Norman, Okla. 73109.

Sloan Fellow—JoAnn Morgan of the Kennedy Space Center recently was awarded a Sloan Fellowship at Stanford University, the first NASA woman to receive that honor. She also was the first KSC woman to receive a NASA Exceptional Service Medal, given for her work on the Skylab program. Morgan joined NASA at KSC in 1963 and has worked on all the U.S. manned space programs from Mercury through Apollo Soyuz. She served as chief instrumentation controller for the launch teams of on Apollo, Skylab and ASTP, coordinating test support activities for the Information System Directorate. Morgan received her B.S. degree in mathematics at the Jacksonville (Ala.) State University.

Did You Know?

More than 40 firms displayed hardware at a Small Business Week Exposition held recently at the Goddard Space Flight Center. Four major aerospace firms had representatives on hand to advise small business firms on subcontracting for major government contracts; the Small Business Administration had a team at the center to advise visitors on SBA procedures and resources.

A cross-section of industry was represented, including: precision machining and tool and die making; electronic displays; mini-computers manufacturing; infrared detectors; spacecraft sensors; precision optics; communication equipment; and closed circuit TV systems.

The enormous quantity of heavy material required for the construction of the Space Shuttle external tank has presented shipping and traffic problems on New Orleans roads leading to NASA's Michoud facility. The assembly facility, part of the Marshall Space Flight Center, is nearly at production capability for the tank, having received 1,118 kilograms (1,298 tons) of equipment in oversized loads aboard 215 trucks arriving from various parts of the country. Statistically, by the time all the material has arrived on tractor-trailers averaging 15 meters or some 50 feet long, the total train length will have reached more than 3,219 meters (two miles). If the trucks were parked side-by-side, they would stretch over 802 m. (half a mile) in width.

NASA recently cosponsored a two-day course entitled "Technology Exchange between the Textile Industry and Government" at Clemson University, S.C. Co-sponsored by NASA's Technology Utilization Office, Clemson University College of Industrial Management and Textile Science, and the Economic Development Administration, the course sought to acquaint textile industrialists with new developments in textile research that have resulted from government-sponsored programs.

The Kennedy Space Center reported that guided bus tours of the nation's spaceport and adjacent Cape Canaveral Air Force Station carried 107,540 patrons during April, some 6,000 more than were reported for April of 1975. Tour total for April 1976 was 6.1 percent more than that of a year ago, bringing total patronage for 1976 to 420,402. April 14 saw a peak day of 6,343 visitors.

An eight-month extension to an existing contract recently was awarded by the Johnson Space Center Serv-Air, Inc., Division of E-Systems, Inc., for continuation of maintenance and modification of JSC aircraft. The extension of the cost-plus-award-fee-contract was for $3.04 million, increasing the total estimated contract value to $12.61 million.

Metro Contract Services, Inc. of Houston has been awarded a $1.3 million contract to furnish logistic support at the Johnson Space Center. Employing about 123 persons on the contract, Metro will be responsible for the management and operation of JSC's logistics support services, which include transportation services, packing and shipping, identification and cataloging, and receipt and inspection of property, among other duties. The contract runs from May 1, 1976 to April 30, 1977.

Pan American World Airways, Inc., Aerospace Services Division, Cocoa Beach, Fla., has been selected for negotiation leading to the award of a contract for engineering support services at the Johnson Space Center. PanAm will be responsible for providing engineering design support for facilities and test programs at JSC. The cost-plus-award-fee contract is for one year, to end May 30, 1977, and is worth about $1.15 million.

Small business contracts for the first three quarters of FY 1976 totalled $29,956,000 at the Marshall Space Flight Center. The figure represents a $5,722,000 increase over the amount awarded to small businesses during the same period in the previous year.

Twenty-four college and university faculty members have been appointed as summer research fellows to work for 10 weeks on selected research projects at the Marshall Center. Working from June 7 through Aug. 13, the fellows will carry out research in aeronautics and space, working in the design and development of scientific payloads, and conduct studies in engineering and in the natural sciences.

Satellite-Ambulance-Hospital Communication

Medical data have been sent from a moving ambulance to a hospital via the satellite GOES-3 for the first time, in demonstrations conducted by scientists and engineers at NASA's National Space Technology Laboratories, Bay St. Louis, Miss.

A special portable transmitter and antenna developed at NSTL by the Science Services Laboratory (operated by the General Electric Company) permit continuous transmission of voice and medical data including electrocardiograms—from the moving ambulance to a satellite and down to a hospital receiving station.

During demonstrations of the system on a Mississippi highway, communications from the ambulance were received as far away as New Mexico. Receiving stations are equipped with an inexpensive receiver that helps make this form of remote health care economically feasible.

The concept is similar to the telemedicine demonstration underway at the Johnson Space Center in conjunction with the Papago Indian Reservation (New Mexico) and to the system used in Alaska for medical communications by way of the ATS-6 satellite. The GOES-3 satellite used in the NSTL system transmits Earth environmental information through its data collection system.

The new system could prove an important breakthrough in emergency medical care. Ultimately it could lead to development of a special medical satellite that would relay emergency medical data not only from ambulances but from remote hospitals, ships, offshore oil platforms and other remote locations to major medical centers for medical consultation.

The system used at NSTL was developed under a program sponsored by the NASA Technology Utilization Office in cooperation with the Southern Regional Medical Consortium, made up of the University of Southern Mississippi, the Southeast Air Ambulance District, the Forrest General Hospital (Hattiesburg, Miss.) and the Mississippi Governor's Office of Science and Technology.

New Chief for Applications

Bradford Johnston recently was named to succeed Charles W. Mathews as Associate Administrator for Applications. Mathews retired from the post last February.

Johnston comes to NASA from private management consultant positions in Milwaukee, Wis. Earlier, his career included sales, marketing and management consulting work with the Link-Belt Co., Johnston Containers, and the Annandale and Congoleum corporations.

A native of Indianapolis, Johnston received his B.A. degree in economics from Wabash College. He won his M.B.A. degree at Harvard Business School.

Composite Materials to Be Studied

A grant awarded by NASA to the Rensselaer Polytechnic Institute at Troy, N.Y., will be used to establish a center for the study of new composite materials and their application to the development of more efficient commercial transport aircraft. The grant, expected to continue over an extended period, provides first-year funding of $300,000. The NASA-RPI association began 15 years ago.

The Rensselaer program will center on how engineers can make wider use of strong, lightweight composite materials such as fiberglass in aircraft designs. Carbon

fibers, which have high tensile properties, will be closely studied.

Use of composites may be able to reduce structural weight of aircraft by as much as 30 percent, thus reducing fuel consumption by 10 to 15 percent. Similar benefits presumably would apply to automotive and rail transportation. Use of composites in the construction industry also might yield important benefits.

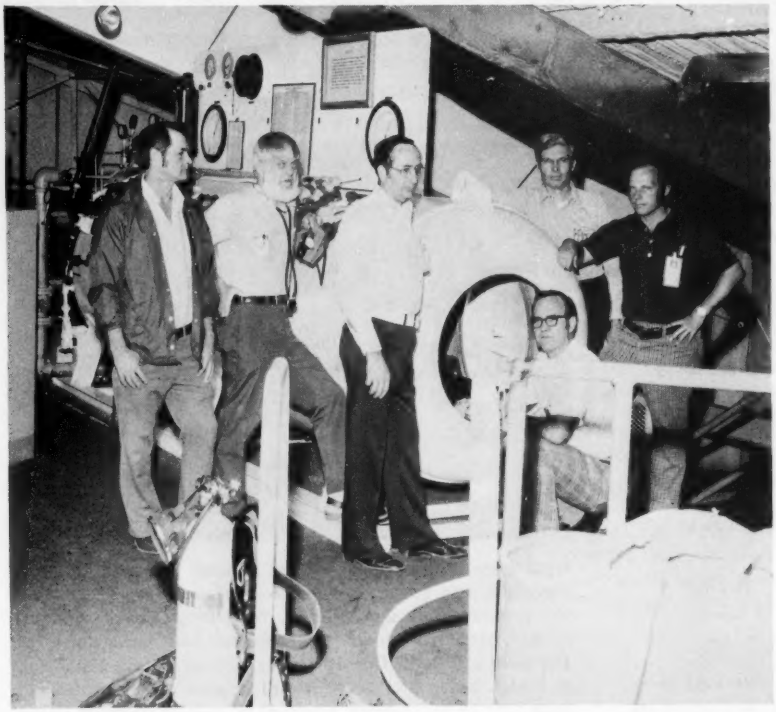
Aviation Safety System a NASA Project

The administration by NASA of an "early warning" aviation safety system for the Federal Aviation Administration will be aided by the Battelle Memorial Institute of Columbus, Ohio, under a recent contract award. The two-year contract, worth $939,000 to Battelle, calls for the institute to assist NASA in implementing a new Aviation Safety Reporting System. The system is designed to obtain reports on potential threats to flight safety, primarily from people in the national aviation system.

Reports on flight hazards will be processed in such a way as to closely protect the anonymity of the individuals reporting. Emphasis will be placed on quick processing of acquired data to permit the FAA to make rapid use of the information to prevent aircraft accidents.

NASA's role is that of a "third party" central collecting station for reports about the safety of U.S. aviation practices, not as a regulatory agency. This approach is designed to encourage voluntary participation by pilots, controllers and others in the aviation system. FAA undertook a similar function a year ago, but found that aviation personnel were reluctant to report directly to a regulatory agency. NASA therefore was invited to be a major participant in the new system.

The Ames Research Center's Dr. Charles E. Billings is project manager for NASA and Dr. John Lauber is the project scientist. Larry Youngren of FAA headquarters is the FAA liaison officer; Gene Lyman of NASA headquarters is the NASA liaison officer.



Emergency Medical Technicians—Six divers and test crewmen assigned to testing operations at the Marshall Space Flight Centers' neutral buoyancy simulator recently completed an 81-hour course entitling them to become emergency medical technicians. Once licenses are issued by the Alabama Medical Association, the technicians will be allowed to perform limited medical treatment in emergency situations under the direction of a medical doctor. The training will permit assistance with emergency medical treatment at the simulator, to include treatment in the recompression chamber. It has been used on several occasions for victims of deep-diving accidents in southeastern waters. Left to right are Clarence Cruse, Donald Hammer, James Martin, Edward Shelton, Bill Edwards and Dave Javins, with chamber in background.

Lovelace Nominated Deputy Administrator

President Ford recently announced his intention to nominate Dr. Alan M. Lovelace as Deputy Administrator of NASA. Lovelace, 46, is presently NASA's Associate Administrator for Aeronautics and Space Technology, where he has served since September 1974.

Lovelace has worked in government posts since 1954. Before joining the NASA staff, he was Director of the Air Force Materials Laboratory at Wright-Patterson Air Force Base from 1967 to 1972. He was Director of Science and Technology with the Air Force Systems Command at Andrews Air Force Base from 1972 to 1974, as well as Deputy Assistant Secretary of the Air Force (Research and Development) for part of the same period.

Lovelace has received numerous awards, the latest being the Air Force Decoration for Exceptional Service, in 1973. He is also the author of many technical papers and a member of several professional organizations.

A native of St. Petersburg, Fla., Lovelace holds a B.S., an M.S., and a Ph.D. in chemistry from the University of Florida. He lives in Severna Park, Maryland.

Lovelace

New NASA Publications

THE SPACE TELESCOPE (NASA SP-392). Contains authors' summaries of the papers on the space telescope that were presented at the 21st annual meeting of the American Astronautical Society held in Denver, Colo. Aug. 27-28, 1975. Paperbound 244 pp., $2.30.

NASA HISTORICAL DATA BOOK, 1958-1968. Vol. 1, NASA Resources (NASA SP-4012). By Jane Van Nimmen and Leonard C. Bruno with Robert L. Roshold. Prepared by the NASA Historical Office, this first volume consists mostly of statistical tables of data from NASA's first 10 years. Volume also contains organization charts plus photographs of headquarters and research centers. Paperbound, 460 pp., $12.50.

Copies may be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Radio-Television

(Released nationally)

TELEVISION: A 4½-minute and a 90-second film have been released in the Aeronautics and Space Report monthly series. They are entitled "Hydrogen-fueled Automobiles."
RADIO: Four weekly *Space Story* programs have released—"Viking Mars Surface Investigations" (Dr. Richard Shorthill, U. of Utah); "Third Century America Exposition" (Miles Ross, KSC); "Search for Martian Biology (Dr. Harold P. Klein, ARC); "Portable Emergency Care Unit" (Sam Pool, JSC). One monthly NASA *Special* Report has been released—"Viking Biology: The Search for Life Elsewhere" (Dr. Harold P. Klein, ARC).

Wyld Award Won by Lazar—The Director of the Space Propulsion and Power Division, John Lazar, (left) recently was presented with the James H. Wyld Propulsion Award by the American Institute of Aeronautics and Astronautics. The division is in the Office of Aeronautics and Space Technology at NASA headquarters. The award is given "for outstanding leadership of this nation's advanced propulsion program in the field of electric rocket propulsion." Lazar, with NASA since 1958, received the agency's Exceptional Service Award in 1974 for his work in electrical propulsion. Presenting the award at the 11th Propulsion Conference held at Anaheim, Calif., is General Chairman of the AIAA/SAE and member of the Boeing Company Bill Reinhard (center). Third man in picture is Roderick Spence, an award winner from the University of California.
(Picture courtesy of AIAA Magazine)

Patents for Inventions from NASA Research

The Office of General Counsel, NASA Headquarters, announces that the following U.S. patents have been issued by the U.S. Patent Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel for the indicated installation.

Inventor(s) and Employer(s)	Title and NASA Docket	Patent No.	Installation
Robert M. Beasley, Alexander Peckman, Lockheed Missiles & Space Co., Sunnyvale, Calif	Coatings for Rigid Silica Composite Insulation	3,955,034	JSC
Marvin B. Dow, Howard G. Bush, William M. Haraway, Jr., NASA/LaRC	Vacuum Pressure Molding Technique	3,956,050	LaRC
John T. Howarth, Arthur A. Massucco, Kenneth R. Sidman, Suresh G. Sheth, Arthur D. Little, Inc., Cambridge, Mass.	Nonflamable Elastic Elastomeric Fiber	3,956,233	JSC
J. Anthony Powell, Herbert A. Will, NASA/LeRC	Process for Fabricating Sic Semiconductor Devices	3,956,032	LeRC
John B. Schutt, NASA/GSFC	Ultraviolet Light Reflective Coating	3,957,675	GSFC
Charles Elachi, Gary A. Evans, Cavor Yeh, Caltech, JPL, Pasadena	Fiber Distributed Feedback Laser	3,958,188	NaPO
Wayne A. Sebrell, Sandia Corp., Albuquerque, N.M.	Inflatable Wing	3,957,232	LaRC
James B. Stephens, Eric G. Laue, Caltech/JPL, Pasadena	Wind Sensor	3,956,932	NaPo
John L. Sullivan, Eugene A. Giorgini, Milo R. Simmonds, Scott Aviation Div. of ATO Inc., Lancaster, N.Y.	Self-Contained Breathing Apparatus	3,957,044	JSC
Billy K. Davis, NASA/MSFC	Solar Energy Power System	3,957,030	MSFC
Leo G. Monford, NASA/JSC	Binary Concatenated Coding System	3,958,238	JSC
Leslie D. Montgomery, Natl. Research Council, Natl. Academy of Science, Washington, D.C.; Dwight L. Moody, Jr., NASA/ARC	Readout Electrode Assembly for Measuring Biological Impedance	3,957,037	ARC
Wendell D. Chase, NASA/ARC	Vehicle Simulator Binocular Multi-Planar Visual Display System	3,956,833	ARC
Andrew Terpay, NASA/LeRC	Method of Making an Apertured Casting	3,957,104	LeRC
Thomas Vranas, NASA/LaRC	High Temperature Strain Gage Calibration Fixture	3,956,919	LaRC
Lott W. Brantley, Jr., NASA/MSFC	Solar Energy Trap	3,958,553	MSFC
Van A. McAuley, NASA/MSFC	Wide Band AC Modulated Control Networks	3,958,179	MSFC

Sunlight Chills

A solar-powered refrigerator is an example of how solar cells, once used only to power satellites in space, now are beginning to be used for a variety of terrestrial applications.

One of the first devices studied under a program sponsored by the Energy Research and Development Agency in conjunction with NASA is a solar-powered refrigerator for remote locations. A standard-sized camper model, the refrigerator has been fitted with three panels of photovoltaic cells that convert the Sun's rays into electrical energy. On sunny days, the electricity is used to run the refrigerator and to charge conventional auto batteries located beneath the unit. The batteries power the system during the evening and on overcast days

The refrigerator is used to keep perishable foods fresh at a remote trail construction camp on Isle Royale National Park, Mich., accessible only by boat or floatplane. Isle Royale, a roadless land of forests and lakes that shelters many wild creatures, is located in northern Lake Superior. The island typifies an area lacking regular electric power and thus is a good site for a demonstration of solar-electric power.

This project, conducted in cooperation with Interior's National Park Service, is the first of many solar cell demonstrations by the Lewis Research Center. Lewis is responsible for the Photovoltaic Test and Demonstration project, a part of the national photovoltaic conversion program directed by ERDA. The center has been actively engaged in transferring space-related solar-cell technology to terrestrial applications since 1971.

Work has included raising solar-cell efficiency while reducing cell and array fabrication costs, as well as demonstrating solar-cell systems in various applications. Although solar-cell arrays still are relatively high-priced, the total life-cycle cost of solar-cell power systems for remote locations is considerably lower than the cost of the fuel and transportation required for alternate power sources.

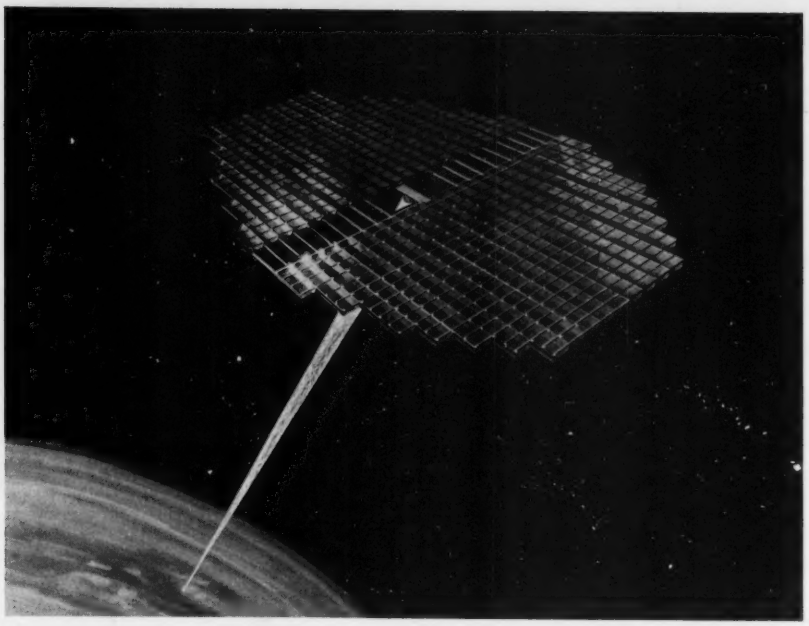
Solar Powered Refrigerator—Members of a trial construction crew use this solar powered refrigerator for storage of perishable foods at the remote Isle Royale National Park in Michigan. A standard camper model, the refrigerator has been fitted with cells that convert sunlight into electrical energy.

Harris Receives Top Award

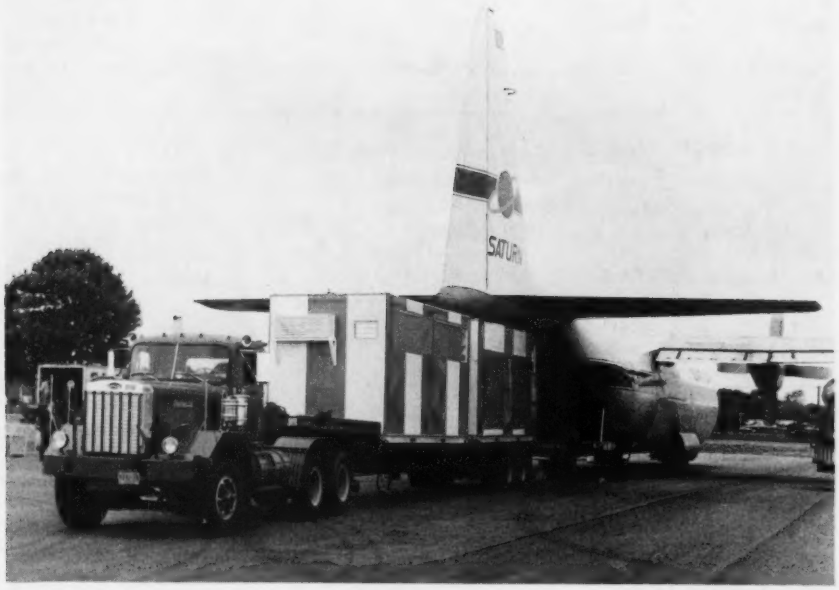
Federally Employed Women, Inc., an organization for opportunity and equality for women in government, presented its 1976 Distinguished Service Award to Ruth Bates Harris at a banquet held July 10 in Washington, D.C.

Harris, NASA's Deputy Assistant Administrator for Community and Human Relations, was praised "for great progress in upgrading the status of women and minorities." FEW's president Janice Mendenhall added: "We believe that your influence has extended not only throughout NASA but has also impacted other Federal agencies. Our organization notes, with encouragement, the visible impetus being given to Equal Opportunity by NASA."

Federal Woman's Award—Ann R. McNair, chief of the Integration Branch at the Marshall Center's data systems laboratory, recently received a certificate of nomination for the Federal Woman's Award from Dr. William R. Lucas, MSFC director. The Federal Woman's Award Board in Washington, D.C. issued the certificate because it considers nomination an honor in itself and awards certificates to all nominees. McNair is the author of several technical papers and a recipient of a number of other awards.



Energy Collector—An artist's concept of one of several configurations of space-based power conversion systems now under study at NASA's Marshall Space Flight Center. A system of this kind could be placed in geosynchronous orbit to collect pollution-free energy from the Sun and transmit it to Earth receiving stations in the form of microwaves for conversion to electricity.



Space Shuttle Equipment—Two all-weather shelters containing glide slope and localizer equipment for the Space Shuttle microwave scanning beam landing system developed for NASA by the Cutler Hammer company are loaded aboard Saturn Airway Hercules at the firm's Farmingdale, N.Y. facility. Equipment is to be installed at Edwards Air Force Base for Space Shuttle landing tests scheduled to begin next year.

Launches for 1976—Completed and Projected

Name	Launch Date	Vehicle	Range	Mission Remarks
Helios-2	Jan. 15	Titan/Centaur	ETR	Scientific satellite to investigate the properties of interplanetary space close to the Sun. Cooperative with Germany.
CTS	Jan. 17	Delta	ETR	Experimental high-powered communications satellite. Cooperative with Canda.
Intelsat IVA-F2	Jan. 29	Atlas/Centaur	ETR	Comsat communications satellite—reimbursable.
Marisat-1	Feb. 19	Delta	ETR	Comsat maritime communications satellite—reimbursable.
RCA-B	March 26	Delta	ETR	Second RCA (Satcom) domestic communications satellite. Reimbursable.
NATO-III A	April 22	Delta	ETR	Communications satellite for the North Atlantic Treaty Organization—reimbursable.
Lageos-1	May 4	Delta	WTR	To demonstrate relevant space techniques that will contribute to the development and validation of predictive models for earthquake hazard alleviation, ocean surface conditions and ocean circulation.
Comstar-1	May 13	Atlas/Centaur	ETR	Domestic communications satellite for Comsat. Reimbursable.
Air Force Test	May 22	Scout	WTR	USAF scientific payload. Reimbursable.
Marisat-B	June 9	Delta	ETR	Second Comsat satellite to provide maritime satellite communications service. Reimbursable.
Relativity	June 18	Scout	Wallops	Scientific probe to test the Einstein Theory.
Indonesia-A (Palapa)	July 8	Delta	ETR	Indonesian communications satellite. Reimbursable.
Comstar-B	July 22	Atlas/Centaur	ETR	Second domestic communications satellite for Comsat. Reimbursable.
ITOS-E2	July 29	Delta	ETR	Operational meteorological satellite of the National Weather Service to provide day and night cloud cover imagery. Reimbursable.
Navy Transit	July 30	Scout	WTR	Navy navigation satellite. Reimbursable.
RCA-C	October	Delta	ETR	Third domestic communications satellite for RCA. Reimbursable.
Marisat-C	December	Delta	ETR	Third Comsat satellite to provide maritime satellite communications service. Reimbursable.
Intelsat-IVA-C	December	Atlas/Centaur	ETR	Third of a series of improved Intelsat satellites. Reimbursable.

Lunar Sample Exhibits

The following is a schedule of lunar sample exhibits from June 15, to July 15, 1976:

North Dakota—St. John Bicentennial Celebration, St. John, June 27.

New York—Science Fiction Expo '76, New York Hilton, New York City, June 25-29.

Ohio—Armstrong Air and Space Museum, Wapakoneta, April 1 to Sept. 1.

Texas—Bicentennial Celebration, Palo Pinto, June 12-19.

Washington—Bicentennial Celebration, Longview, June 28 to July 5.

American Freedom Train—Harrisburg, Penna., June 19; Philadelphia, June 24: New York City, July 14.

High Flight Bicentennial Mobile Space Museum—Lovington, N.M., June 15-20; California—Marysville, June 26-30, Sacramento, July 1-4, San Jose, July 6-11, Bakersfield, July 12-18.

Tennessee Valley Association—Bicentennial Caravan—In Tennessee: Knoxville, June 13-17; Oak Ridge, June 19-21; Loudon, June 22; Athens, June 23; Madisonville, June 24; Maryville, June 25-26; Sevierville, June 27-29; Newport, June 30; Greenville, July 1-2; Erwin, July 3; Jonesboro, July 4-6; Elizabethton, July 7; Bristol, July 8-9; Rogersville, July 10; Kingsport, July 11-13; Morristown, July 14-15.

Long Term Displays

Alabama—Alabama Space and Rocket Museum, Marshall Space Flight Center, Huntsville.

Florida—Visitor Information Center, Kennedy Space Center.

Kansas—Eisenhower Library, 200 S.E. 4th St., Abilene.

Mississippi—The National Space Technology Laboratories, Bay St. Louis.

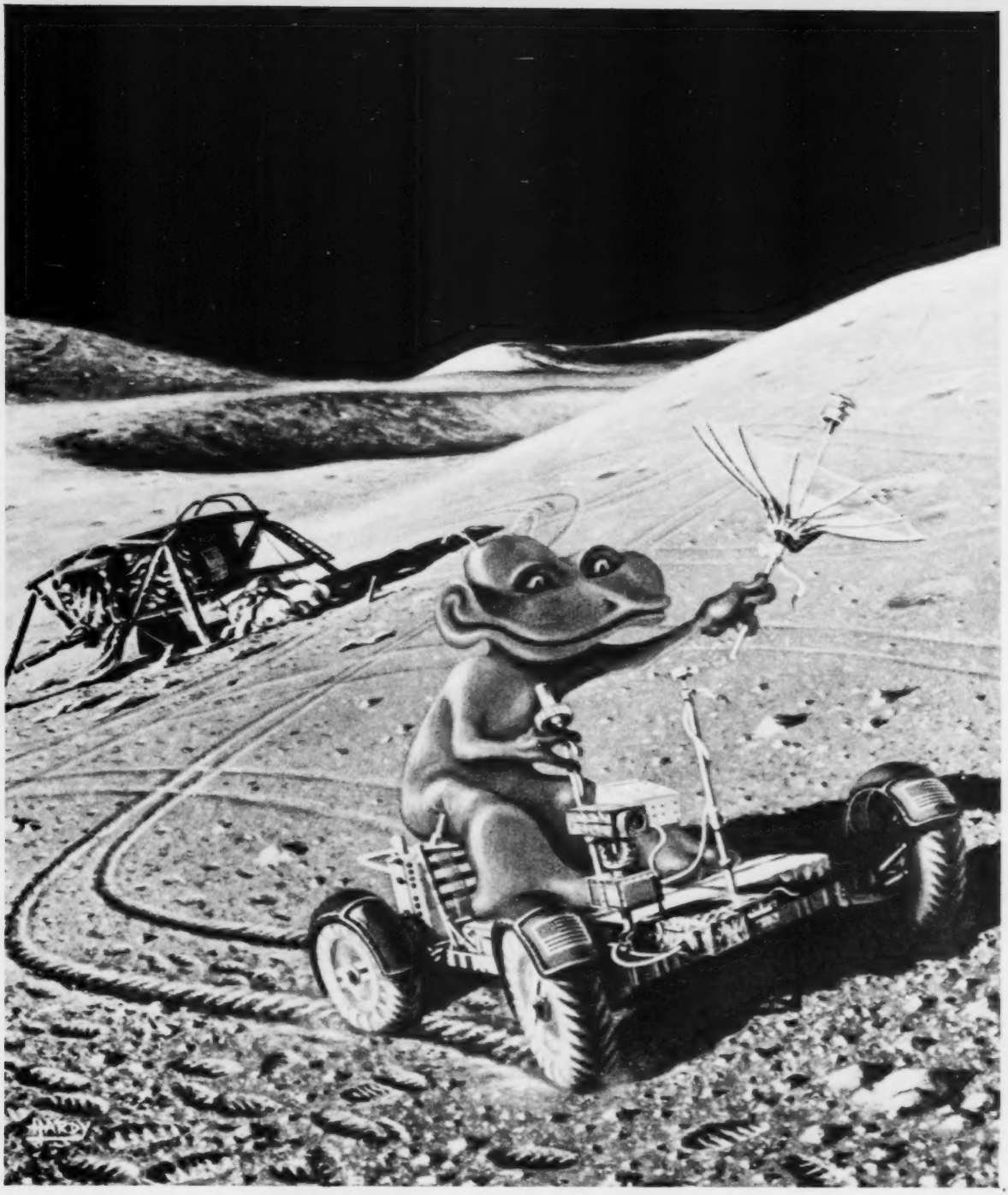
New York—United Nations Building, New York City.

Ohio—USAF Museum, Wright Patterson, AFB.

Texas—Johnson Library, University of Texas, Austin; Visitor Information Center, Johnson Space Center, Houston.

Virginia—Visitor Information Center, Langley Research Center, Hampton.

Washington, D.C.—National Geographic Museum; Smithsonian Institution, National Air and Space Museum, Washington National Cathedral.



Hadley Base Revisited—British space artist David A. Hardy revived memories of the Apollo missions in this cover of the *Magazine of Fantasy and Science Fiction*. Hardy's brainchild, the alien "Bhen," is seen taking a joyride on the lunar rover abandoned at Hadley Base by Apollo 15 astronauts. The British magazine has used Hardy's imaginative character on several occasions to illustrate space subjects.

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More Efficient Foam Insulation on Ships

Polyurethane foam insulation systems developed in the space program to insulate the liquid hydrogen tanks of the Saturn V launch vehicle, currently are being used in the shipping industry.

Two firms, McDonnell Douglas Astronautics Co., and Rockwell International Corp., under contract to the NASA-Marshall Space Flight Center, developed the technology for efficient cryogenic (low temperature) tank insulation. McDonnell Douglas developed its system for the third stage (S-IVB) tanks, while Rockwell International developed a system for tanks in the second stage (S-II).

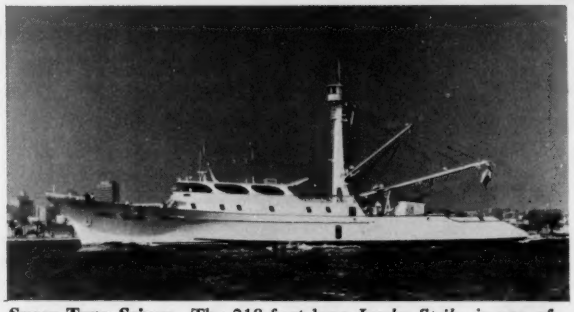
The system utilizes a service-proven gas-transport insulator, called the Invar membrane, and the three-dimensional reinforced foam insulation developed by McDonnell Douglas. The two companies call their new system the GT/MDC Liquefied Gas Compartment System.

After extensive testing in the United States and France, the U.S. Coast Guard has granted its approval to the GT/MDC system. Coast Guard approval is required for designs used in hazardous cargo tankers such as carriers of liquefied natural gas.

Rockwell International has adopted its system and application procedures for insulation aboard commercial fishing vessels. The polyurethane insulation has been in use on tuna boats, for example, since 1970, replacing the conventional cork and fiberglass systems formerly used. Spokesmen for the fishing industry say that the insulation is far more reliable, efficient and economical than other kinds used in the past. To date more than 40 tuna boats—in the $1 to $4 million price range—equipped with the new insulation have been completed and sold. Campbell Industries of San Diego originated and developed the idea using the insulation aboard commercial fishing vessels.

The insulation typically is used around fish wells. The fish wells, which fill the lower portion of a boat, resemble large steel boxes with voids underneath, on all sides, and between the top and the deck above. The voids are filled with polyurethane foam. Around the interior of each of the wells is a series of ammonia pipes which, when in operation, chill the supersaturated brine solution within the wells. Freshly caught fish are loaded into the wells for freezing.

Walk-in type refrigerators holding meat and vegetables aboard ships are similarly insulated. Many vessel operators also find it expedient to spray the interior steel surfaces of decks or cabin roofs and sides exposed to the sun with a spray-on type of polyurethane, covering the material with paneling.



Super Tuna Seiner—The 218-foot long *Lucky Strike* is one of the modern "floating palace" fishing boats that travel throughout the world's oceans catching tunas. Owned by Pan Pacific Fisheries, the 40-foot beam vessel has a capacity of 1,100 tons of fish. *Lucky Strike* is one of 40 or more commercial fishing vessels that uses insulation first developed for space programs.

NASA

National Aeronautics and
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